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DECLARATION

The material in this thesis are original except for quotation, summaries and references, which have been duly acknowledged.

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ABSTRACT

This study was mainly conducted in the Salut-Mengkabong lagoon located in the west coast of Sabah, Malaysia. Three different transect were found in the main inlet as well as Salut and Mengkabong entrance of the lagoon. The focus of the study is on the physical water properties of the lagoon. They are temperature, salinity, dissolved oxygen and also pH. The objective of the study is to understand the temporal variation of physical water properties. It aims to determine the effects of the tidal dynamic and the physical water properties at tidal inlet. This study will also investigate the effects of variation of physical water properties at different monsoon. The measurements were taken at spring tide and neap tide of September 2005 (North East monsoon) and February 2006 (South West monsoon). The output of the study shows that, all the physical water properties which had been examined show a strong connection with the tidal cycle. There are plenty of factors that had been directly or indirectly influencing the output. They are time tide, local climate, and wind action.

ABSTRAK

Kajian ini dilakukan di muara Lagun Salut-Mengkabong yang terletak di pantai barat Sabah, Malaysia. Terdapat tiga transek yang telah dikenalpasti di bukaan utama muara Lagun Salut-Mengkabong, dan juga di kedua-dua laluan masuk Lagun Salut-Mengkabong. Fokus kajian ini adalah untuk mengkaji kandungan fizikal air lagun. Antara kndungan fizikal yang dikaji adalah suhu, saliniti, oksigen terlarut dan juga pH. Objektif kajian ini adalah,untuk memahami kandungan fizikal air lagun melalui variasi masa. Di samping itu, ia juga untuk tujuan pengukuran kandungan fizikal air lagun pada monsun yang berbeza. Semua parameter telah disukat dengan menggunakan YSI-multer sensor. Proses penyukatan dibuat pada air pasang purnama dan air pasang surut anak bagi bulan September 2005 (monsun timur laut) dan bulan Februari 2006 (monsun barat daya). Keputusan kajian menyatakan bahawa semua parameter yang dikaji mempunyai ikatan yang kuat dengan masa, air pasang-surut, aliran angin dan juga musim cuaca.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The lagoons are the most valuable components of coastal areas in terms of both the ecosystem and natural capital. Coastal lagoons are most common long microtidal, high wave energy coasts, where the coastal plain has been subjected to submergence during sea level rise, and alternatively flooded and exposed by sea level fluctuation.(Gacˇic´ *et al.*, 2002). A lagoon or bay connected to the ocean by an inlet has a tide that is smaller than that of the ocean due to the flow restriction imposed by the small cross-sectional area of the inlet. Narrowing to the study area which include the tidal inlets, where the tidal inlet means the area which is located along tidally influenced barrier beaches (islands or spits), (Schwartz, 1973). According to Hayes (1979), tidal inlets occur primarily in mesotidal coasts (tidal range = 2–4 m), having medium wave energy (mean significant wave height = 60–150 cm).

Perhaps the most important lagoon in the northern part of Kota Kinabalu is the Salut-Mengkabong Lagoon. This Lagoon is made up of a combination of different ecosystems including seagrass beds, mangrove forests, mudflats, rocky shore and beach forest. Besides that, Salut-Mengkabong Lagoon is an active place subjected to natural events and processes which can be recognized at tidal inlet and the coast shore line. At this location, the wind wave breaks and expends their energy at end of the tidal inlet. Tides sweep water on and off the inlet which rivers drop most of their sediments at the lagoon and ocean storms batter the continents as well as wind wave. The shape of Salut-Mengkabong Lagoon coast is a product of many processes: uplift and subsidence, the wearing down of land by erosion, and the redistribution of material by sediment transport and deposition at the end of river mouth.

The surrounding areas of Salut-Mengkabong lagoons provide excellent opportunity for agriculture and tourism sectors in one hand and for fishery and aquatic products sectors on the other hand. Due to the fast development of this area, the water properties would have been redirected from its neutral condition. The flow of seawater in and out of this lagoon has a strong connection with the changes of salinity, temperature, pH and dissolved oxygen.

1.2 Objectives

i. To study the temporal variation of salinity, temperature, pH, and dissolved oxygen (DO)

ii. To determine the effects of tidal dynamic and the physical water properties at the tidal inlet.

iii. To investigate the effects of variation of physical water properties at different monsoons.

1.3 Significance Of Study

This study is mainly to provide an overall picture on velocity and physical water properties through time at the main inlet, as well as the Salut and Mengkabong entrances. The findings of this study can be used for studying inlet stability and for conducting any modeling studies. Other than that, the outcome of the study can be used for predicting hydroenvironmental hazards for coastal lagoon environments. The findings of this study will also be useful for the sustainable maintenance of the existing or ongoing projects and also for planning and designing other projects in lagoon and other coastal zone areas.

CHAPTER 2

LITERATURE REVIEW

2.1 Coastal Lagoon

Coastal lagoons border more than 13%, or 32000 km, of the world's continental coasts (Kjerfve, 1986). Lagoons play a substantial role in the transport, modification, and accumulation of matter at the land sea interface. Primary production rates usually range from 200-500 $gCm^{-2}yr^{-1}$, and the global contribution of coastal lagoon primary production reaches 10^{11} $kgCyr^{-1}$, which is approximately the same as the production rate of global coastal upwelling (Kjerfve, 1986). Fishery yields are commonly 50-120 t $ha^{-1}yr^{-1}$ and a variety of commercially valuable species breed in coastal lagoons (Kjerfve, 1986).

Coastal lagoons occupy more than 10% of coastal areas worldwide and are influenced both by anthropogenic and natural factors (Kjerfve *et al.,* 1996). Water exchange between lagoons and open sea is controlled by tides, atmospheric forcing on (non-tidal) low frequencies and by the freshwater discharge (Janzen and Wong, 2002). The relative importance of external forcing and oceanographic properties of lagoons depend on their physical characteristics (geometry, number of inlets and their width and depth) as well as on local climatic conditions (Kjerfve, 1986).

Coastal lagoons are shallow aquatic ecosystems that develop at the interface between coastal terrestrial and marine ecosystem. They are driven to major extent by the high density of noncommercial auxiliary energy and mass exchange with the surrounding ecosystem. The rate of structural and functional change to hydrogeomorphological units and biological communities are particularly dependent on the exchanges of auxiliary energy and mass (Zuliani *et al.,* 2001). Although lagoons are intricately connected to surrounding environment, they develop mechanisms for structural and functional regulation which results in specific biological productivities and carrying capacities. As pointed out previously, coastal lagoons are more productive than other ecosystems in terms of fisheries yield (Pauly, 1994). They are important in the life cycles of many coastal fishes, allowing a high standing stock.

2.2 Tidal Inlet

Tidal inlets generally have a short, narrow channel passing between two sandy barrier islands and connect the ocean to a bay. The inlet provides a means of water flow between the ocean and the lagoon system. The two most important features of a tidal inlet are the ebb and flood tidal shoals, which may be very voluminous features that began when the inlet was created (Kana, 1989). In inlets with large open bays and small tidal amplitudes, flows can be dominated by wind stress. In such cases, ebb conditions can last for days when winds pile up water near the bay side of the inlet, or long floods can occur when winds force bay water away from the inlet.

Tidal inlet cutting through offshore barrier islands provide many benefits, including navigational access to the lagoon for commercial shipping, fishing, and recreational boating. Also, the exchange of lagoonal water during a tidal cycle plays a major environmental role, flushing the bay of sediments and pollutants and maintaining water quality and salinity levels for aquatic life.

Many tidal entrances are so old that no records are available on the time of their birth, therefore no descriptions of their development existed until very recently. The fluctuation of sea level (Bruun, 1962) often played a major role in the development of tidal bays, lagoons and barriers.

2.3 Distribution of physical water property in the lagoon.

2.3.1 Salinity

The term salinity is often related to the amount of salt in the water. In oceanography, salinity is defined as "the total amount of dissolved solids in seawater." There are many different types of solids dissolved in water, but most common dissolved solids are sodium chlorine (NaCl). Dissolved solids are often called salts. Salinity is measured in parts per thousand by weight, and is symbolized ‰. The measurement gives us the grams of dissolved material per kilogram of seawater (Pollard, 2002).

Salinity in the lagoons varies according to fresh water runoff, local climate, the geomorphology of lagoon cells and ocean connection, and degree of tidal choking (Gerardo, 1999).Tides also affects the salinity in these water bodies. When the tide is high, the salinity may be higher than when the tide is low (salinity Protocol).

Freshwater contains few salts and thus has low salinity. The Salut-Mengkabong Lagoon is a site of mixing for freshwater and sea water. Since sea water enters the Salut-Mengkabong Lagoon at the inlets, the salinity is highest at that point and decreases as one moves away from the inlets toward the freshwater inputs. Generally, the salinity of lagoons will normally vary between 0 and 35 ppt (Björk, *et al.,* 2000). Since sea water has an average salinity of 35 ppt, on a given day in the lagoon, it is possible to measure salinity greater than 35. This is because, in some areas, evaporation is a major controlling force for salinity. There is also a trend of increasing salinity at times of the year when little or no rainfall is occurring.

One important aspect of salinity is the density difference it causes. Sea water has a higher density than fresh water due to the dissolved salt. These waters will ultimately mix, but where that mixing occurs will depend on tides, winds and the volume of freshwater (Björk, *et al.,* 2000). Immediately after heavy rainstorms, the head of freshwater will push further out into the lagoon and can cause a decreas in the overall salinity in the lagoon. Probably the most important aspect of salinity with regards to water quality is its effect on aquatic organisms inhabiting the Lagoon. Salinity changes can affect the well being and distribution of biological populations.

2.3.2 Temperature

Temperature is one of the important parameters to be considered when examining water quality. Many biological, physical and chemical parameters are dependent on temperature and it can dramatically affect the rates of chemical and biological reactions. Some of the more common things which temperature can have an affect upon are: the solubility of chemical compounds in water, the distribution and abundance of organisms, the rate of growth of biological organisms, water density, mixing of water of different densities and current movements.

The amount of oxygen that can dissolve in water is dependent upon temperature. The solubility of oxygen decreases as the temperature of the water increases. According to Ridderinkhof *et al.,* 2002, the temperature, specific gravity, and salinity are also intimately interrelated. For a body of water of given salinity, as the temperature of the water decreases, the specific gravity will increase and the water becomes more dense. Conversely, as the water warms up, the water will expand and the specific gravity will decrease. This can be an important consideration in evaluating the mixing of waters of different densities.

The Salut-Mengkabong Lagoon is generally shallow. Its capacity to store heat over time, therefore, is relatively small. The water temperature of the lagoon will rise sharply during the hot season and decrease markedly during the raining season. Wind action serves as the most important mixing phenomenon in the lagoon, because it is shallow. Thus, temperatures at the surface and at the bottom tend to be very similar.

2.3.3 Dissolved Oxygen (DO)

The dissolved oxygen concentration refers to the amount of oxygen contained in water. Dissolved oxygen (DO) is one of the most important indicators of water quality (Jos ´e and Catarina, 2006). It is essential for the survival of fish and other aquatic organisms that inhabit the Lagoon. Oxygen dissolves in surface water due to the aerating action of winds. Oxygen may also be introduced into the water as a by-product of plant photosynthesis. When levels of dissolved oxygen become too low, fish and many other aquatic organisms cannot survive.

The dissolved oxygen test tells how much oxygen is dissolved in the water. However, it does not tell how much oxygen the water is capable of dissolving at the temperature at which it was measured. When water dissolves all of the oxygen it is capable of holding at a given temperature, the water is said to be 100% saturated. The colder the water is, the greater the amount of oxygen the water can hold. As the water becomes warmer, less oxygen can dissolve in the water. Salinity is also an important factor in determining the amount of oxygen that a body of water can hold. As the amount of dissolved salt in water increases, the amount of oxygen the water can hold decreases. Conversely, as the water becomes more fresh (has lower salinity), more oxygen can be dissolved (Wood and Widdows, 2002).

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